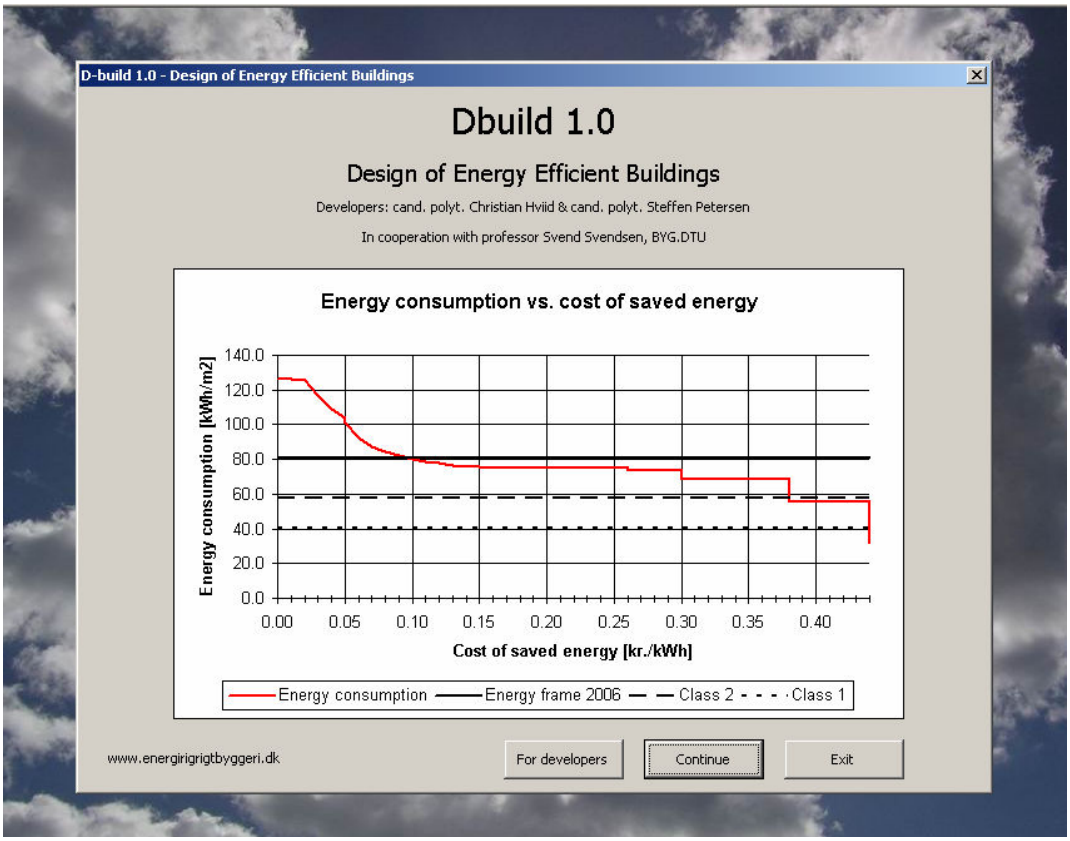
Metode til optimering af nyt lavt boligbyggeri til lavenerginiveau -User guide to Dbuild



Eksamensprojekt ved Danmarks Tekniske Universitet, BYG•DTU

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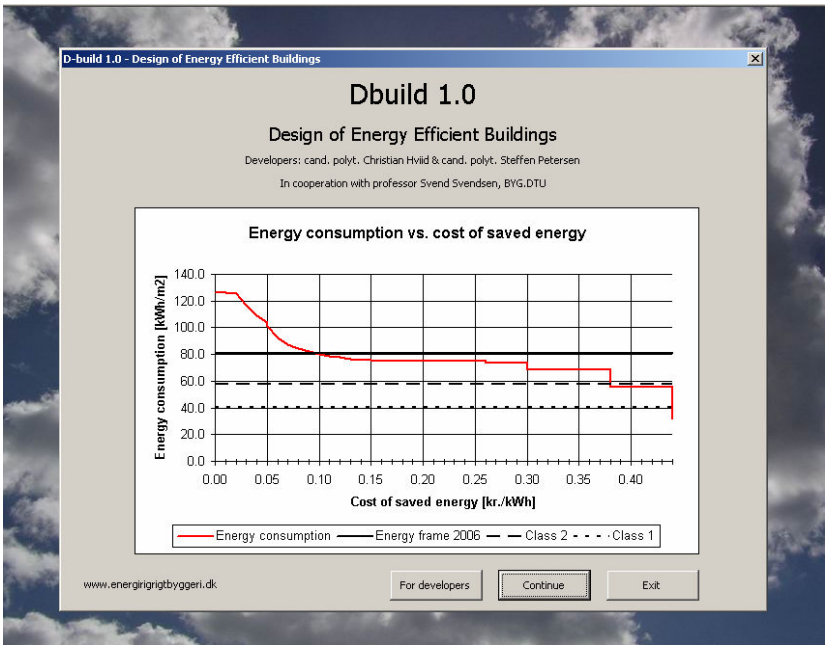
1 User guide to Dbuild

The computer program Dbuild is a tool for optimization of energy performance in buildings. Dbuild is an abbreviation of DEEBuild (both pronounced the same way), which is short for “Design of Energy Efficient Buildings”.



This version of Dbuild, version 1.0, only applies for dwellings but the user form is ready for implementation of an extended version that handles other types of buildings.

In this user guide Dbuild is described tab by tab. Each feature and parameter in the user form is described and explained in chronological order as the user goes through the program. Sometimes the user guide refers to a “Design guide” for further details, which is “Metode til optimering af nyt lavt boligbyggeri til lavenerginiveau; Del B: Designguide til energirigtigt byggeri”. This design guide is currently only available in Danish.

1.1 How to get started?

Dbuild is downloadable from the web page www.energirigtigtbyggeri.dk. It is based on Microsoft® Office Excel which is found in a number of editions. Dbuild version 1.0 is currently available for the following versions of Excel:

- Microsoft® Office Excel 2002
- Microsoft® Office Excel 2003

The version of Excel on the work station can be determined as follows:

> *Open Microsoft Excel → Click "Help" in the menu → Select "About Microsoft Office Excel" → Read the version info, e.g. "Microsoft® Office Excel 2003"*

First time you use Dbuild, you must set up your version of Excel as follows:

- *Security level;* the security level has to be "low" or "medium" level. You must accept all macros if asked when program is executed. Security level is set as follows:
  Click "Tools" in the menu → select "Macro" → select "Security..." → choose "Low" or "medium" level → Click "Ok"

- *Solver add-in;* Dbuild needs a "Solver add-in" which is not installed in a standard setup of Excel. The "Solver add-in" is applied as follows:
  Click "Tools" in the menu → select "Add-ins..." → mark the checkbox next to "Solver add-in" → Click "Ok"

- *Initialize solver;* the solver needs to be initialized. This is done as follows:
  Click "Tools" in the menu → select "Solver..." → click "Close"

NB: This only has to be done the first time you use Dbuild. But every time you want to start up the program you have to do it as follows:

- *Open Excel separate before opening Dbuild*
- *Initialize solver;* the solver needs to be initialized. This is done as follows:
  Click "Tools" in the menu → select "Solver..." → click "Close"

Now the program is ready to be opened in Excel. Accept all macros when asked.

Start up the program in its own folder as Dbuild is generating temporary files, which is stored on the computer when the program is executed. Open Dbuild from within Excel after initializing the solver. Furthermore, when using Dbuild please remember to:

- Use point (.) as separator in case of decimal numerals, e.g. “54.23”, or the program will corrupt.
- Fill out every tab in the program (except “Other measures” and “Costs and service”) before you press “Optimize” in the tab “Window” to ensure a correct window optimization.
- Always be critical to input and output data in Dbuild

Any problems or comments, please contact info@energirigtigtbyggeri.dk.

1.2 Hvordan kommer jeg i gang med Dbuild?

Dette er en dansk oversættelse af afsnit 1.1: How to get started?. Oversættelsen er udarbejdet, da nogle brugeres version af Excel er på dansk, og det kan være vanskeligt at oversætte de engelske begreber i Excel til de tilsvarende danske begreber.

Dbuild kan downloades fra hjemmesiden www.energirigtigtbyggeri.dk. Dbuild er baseret på Microsoft® Office Excel, der forefindes i forskellige udgaver. Dbuild version 1.0 er indtil videre tilgængelig til følgende udgaver af Excel:

- Microsoft® Office Excel 2002
- Microsoft® Office Excel 2003

Udgaven af PC'ens Excel kan bestemmes som følger:

> *Åben Microsoft Excel → klik "Hjælp" i menuen → Vælg "Om Microsoft Office Excel" → Læs udgave f.eks. "Microsoft® Office Excel 2003"*

Før Dbuild startes er det nødvendigt med følgende indstillinger i Excel:

- *Sikkerhedsniveau;* sikkerhedsniveauet skal være "lav" eller "medium" niveau. Brugeren skal acceptere alle makroer hvis der spørges ved programmets opstart. Sikkerhedsniveauet stilles som følgende:
  Klik "Funktioner" i menuen → vælg "Makroer" → vælg "Sikkerhed..." → vælg "Lav" eller "medium" → Klik "Ok"

- *Tilføjelsesprogrammer*; Dbuild skal bruge "Tilføjelsesprogrammet Problemløser", som ikke er installeret i standard opsætningen i Excel. Denne tilføjes som følgende:
  Klik "Funktioner" i menuen → vælg "Tilføjelsesprogrammer" → marker checkboksen ved siden af "Tilføjelsesprogram Problemløser" → Klik "Ok"

- *Initialiser Problemløser*; Problemløseren skal initialiseret. Dette sker som følgende:
  Klik "Funktioner" i menuen → vælg "Problemløser..." → Klik "Luk"

NB: Ovenstående skal kun gøres første gang Dbuild bruges på den pågældende computer. Men fremover er det vigtigt at starte Dbuild på følgende måde:

- *Åben Excel seperat før Dbuild åbens.*
- *Initialiser Problemløser*; Problemløseren skal initialiseret. Dette sker som følgende:
  Klik "Funktioner" i menuen → vælg "Problemløser..." → Klik "Luk"

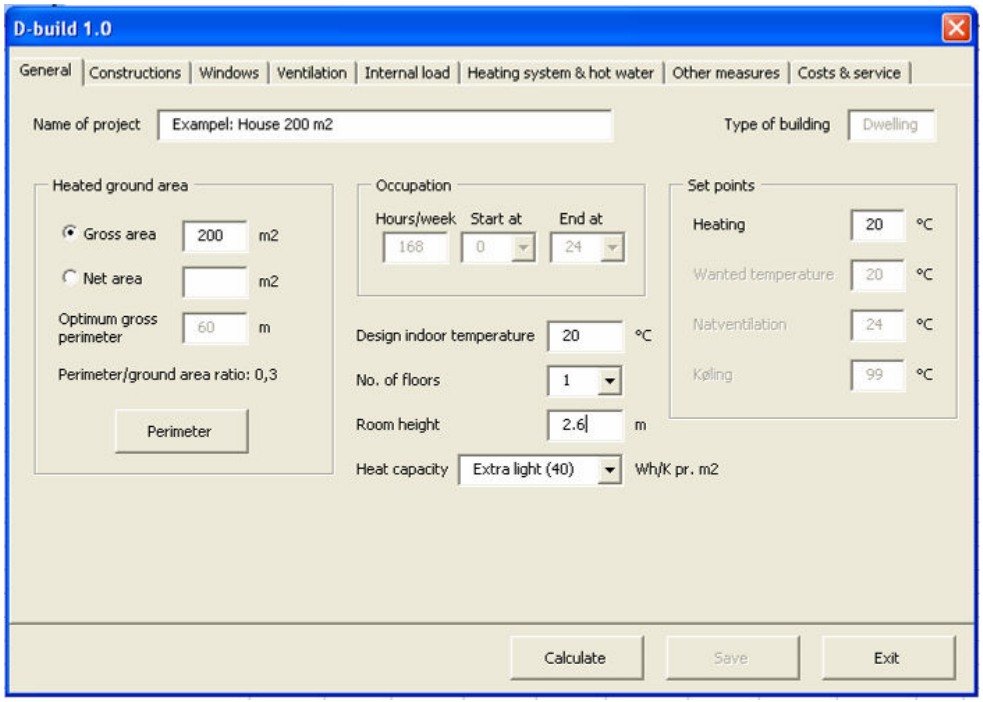
Nu er programmet klar til at blive åbnet i Excel. Accepter alle makroer Excel spørger.

Start Dbuild i sin egen mappe, da Dbuild genererer en række foreløbige filer, som bliver gemt på computeren når Dbuild køres. Åben Dbuild indefra Excel efter du har initialiseret 'Problemløseren'. Ydermere, så husk følgende ved brugen af Dbuild:

- Brug punktum (.) som separator i decimal tal, f.eks. "54.23", ellers opstår der fejl i programmet.
- Udfyld alle faneblade i Dbuild (undtagen "Other measures" og "Costs and service") før der trykkes på knappen "Optimize" i fanebladet "Window" for at sikre en korrekt vinduesoptimering.
- Vær altid kritisk over for input og output data i Dbuild.

Hvis du har problemer eller kommentarer, kontakt da info@energirigtigtbyggeri.dk.

1.3 General



Name of the project
The users own call name or description of the project.

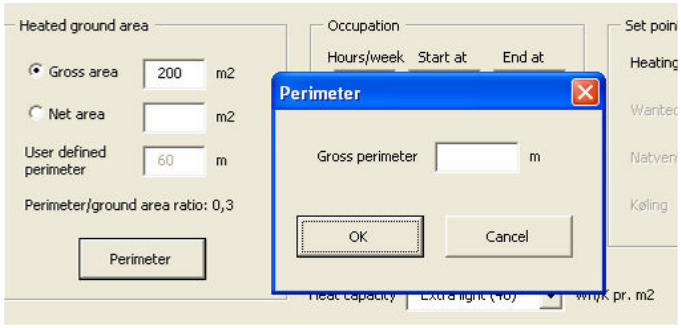
Type of building
The type of building is a "dwelling". Dbuild can only handle dwellings in this 1.0 version.

Heated ground area
The user can choose to fill in the gross area of the building (the area based on the outside measures of the building) or the net area (the inside measures of the building).
Depending on what kind of area the user is filling in (gross or net), Dbuild generates the optimum perimeter (smallest perimeter) of the building. This optimum is calculated under the following assumptions:

- Rectangular building; minimum perimeter (see "Design guide", section **Fejl! Henvisningskilde ikke fundet.**)
- Maximum width of building is 10 m; to assure sufficient day light penetration.

Knowing the "Heated ground area" and the perimeter of the building Dbuild automatically calculates the perimeter/ground area ratio (for further information about perimeter/ground area ratio, see "Design guide" section **Fejl! Henvisningskilde ikke fundet.**).

Button: "Perimeter"
If the user at some point comes up with a specific geometry that is different from the optimum geometry as defined above, the perimeter of the new building geometry must be applied by pressing the "Perimeter" button in "Heated ground area" and filling in the new perimeter.



Occupation
The occupation time of a dwelling is according to (Be05, 2005) 168 hours a week, start at 0 and end at 24. This corresponds to an occupation time of 24 hours a day the whole week throughout the year. These values are currently fixed by Dbuild (version 1.0).

Set points
The user may fill in set point temperatures for the heating system and the wanted indoor temperature.

The text boxes "Night cooling" and "Cooling" are not relevant for dwellings and are therefore not active in Dbuild version 1.0.

No. of floors
The user fills in the number of floors in the building, which in Dbuild version 1.0 is limited to 1 or 2 floors.

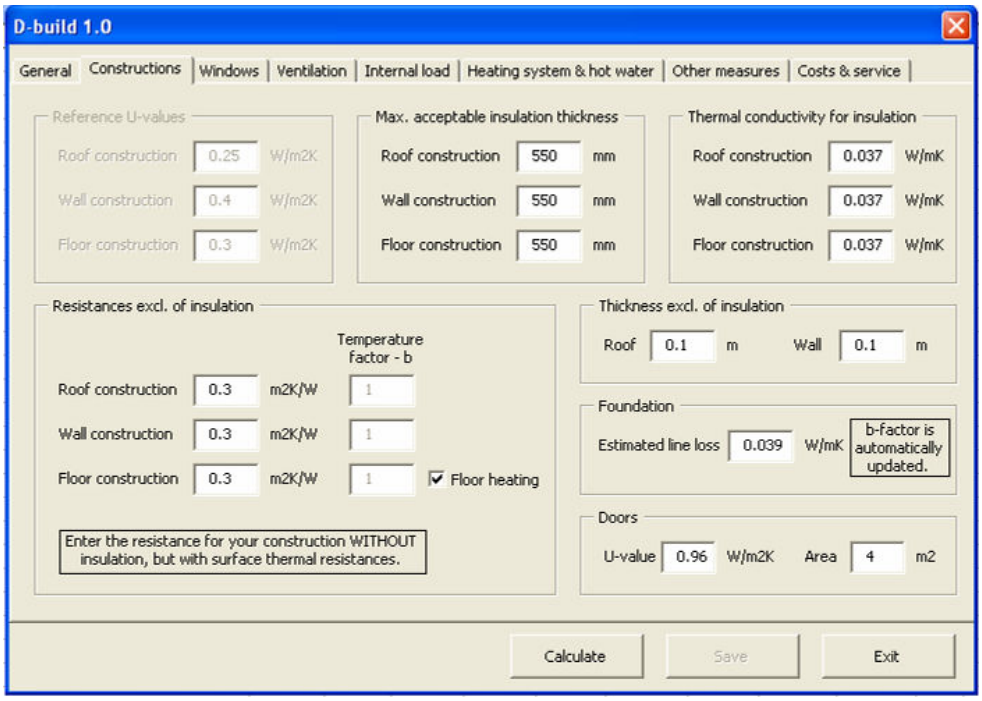
Room height
The user inserts the room height of the building. The room height is defined as the internal measure from floor surface to roof surface. In case of multiple floors 0,2 m is automatically added as deck divider.

Heat capacity
The user indicates the heat capacity (Wh/K per m^2) of the building. The capacity is divided into four categories (defined in SBi 208):

- Extra light; 40 Wh/K per m^2 – building all made of light materials
- Medium light; 80 Wh/K per m^2 – some parts of the building are heavy materials

- Medium heavy; 120 Wh/K per m^2 – a large part of the building is heavy materials
- Extra heavy; 160 Wh/K per m^2 – building all made of heavy materials

1.4 Constructions



Reference U-values
These values are default reference U-values of the part constructions that cannot be changed. The calculation of energy savings is based on a reference house that uses these values (minimum U-values according to (Tillæg 9, 2005)).

Max. acceptable insulation thickness
The default value of max. acceptable insulation thickness is 600 mm for each construction part. The user can change this value if required. It is recommended to keep a relatively high value in relation to the energy optimization. Please note that the optimization always will suggest a lower value than the one intended especially when optimizing on the basis of gross area.

Thermal conductivity for insulation
These values are the thermal conductivity (λ-value) for insulation in the part construction. Default value is 0.037 W/mK, which is the thermal conductivity of a standard insulation product. The user may fill in another value if desired.

Resistances excl. of insulation

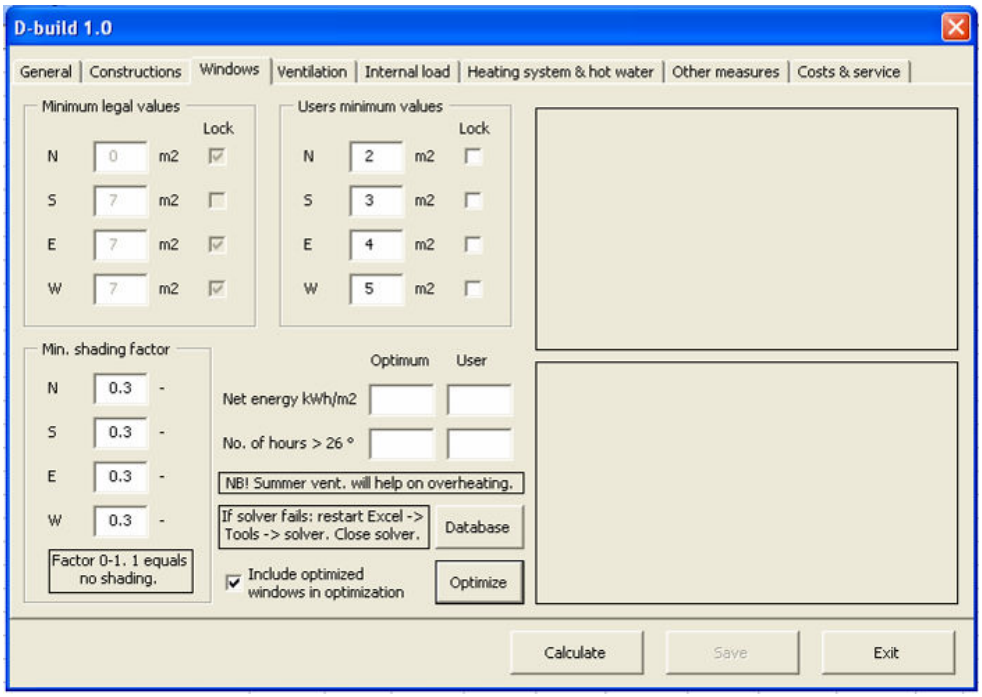
The resistances of the part constructions excl. of the resistance of the insulation. The other materials of the part constructions have thermal resistances that need to be calculated and given in Dbuild due to the transmission area calculations according to (DS418, 2002) section 6.

The temperature factor (b) is determined according to (Be05, 2005). The value of the factor is 1 as default. If the ground floor is without floor heating the value must be 0.7. In version 1.0 crawl spaces are not supported.

Thickness excl. insulation
The user fills in the thickness of the part constructions. This is necessary to calculate the net area of the building foot print (heat transmission area according to (DS 418, 2002) section 3.6)

Doors
The user fills in the total area of external doors in the building and the U-value of the doors. If e.g. two external doors have different U-values, an average U-value should be used.

1.5 Windows



Min. legal start values

Minimum legal start values are the start values needed for the optimization to start and take place. The values are an area of windows generated automatically by Dbuild based on regulations from the Danish working environment authority. The regulation recommend that the sum of window areas in the building should be at least what corresponds to 10% of the floor area (www.at.dk).
Dbuild then assumes that these 10% of the floor area are distributed in the cardinal direction with the factors in Tabel 1.1:

Tabel 1.1. Distribution of windows in the cardinal directions starting from south or SW/SE

Main facade direction: South	*Factor*	*Lock*
North (N)	0.00	√
South (S)	0.33	
East (E)	0.33	√
West (W)	0.33	√

Main facade direction: SW/SE	*Factor*	*Lock*
Northwest (NW)	0.25	
Southeast (SE)	0.25	√
Northeast (NE)	0.25	
Southwest (SW)	0.25	√

In Tabel 1.1 “Main facade direction: South” the window area is only distributed to the S, E and W direction (0.33 in each direction) because windows in the north direction under any circumstances will lead to an energy loss. Furthermore, for rooms placed with a corner in e.g. the northwest direction a window should be placed in the west facade rather than in the north facade – thereby obtaining the needed window area in the room in the most energy efficient way.
In an optimization process without restraints Dbuild would maximize the window area to the south and minimize (eliminate) windows areas to the other directions. Because of this the factors in Tabel 1.1 are “locked” in the N, E and W direction. This means that the areas in these directions are constant when the button “Optimize” is pressed and the demands in (www.at.dk) are thereby met.
Same principles applies for “Main facade direction: SW/SE” in Tabel 1.1.

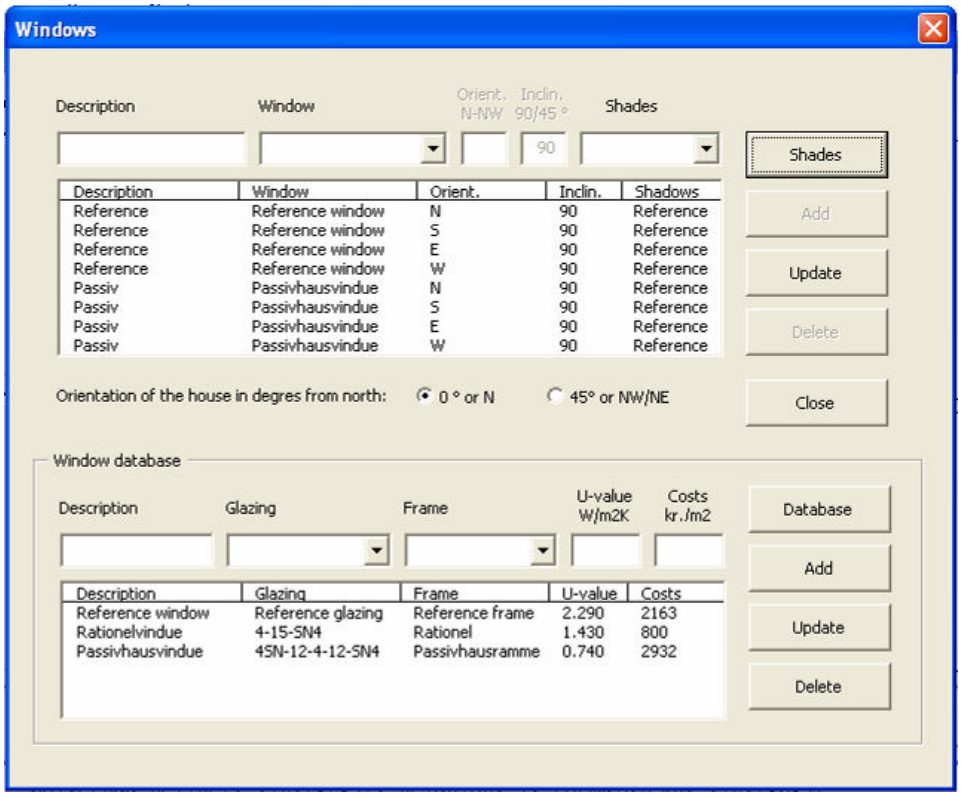
User start values

If the user has any other preferences to the start values than the minimum legal start values it is possible to change these in this setting.
If the user wants an exact area of windows in one or more directions, simply mark the check box “Lock” next to the direction.

Max. shading factor

The user can define the maximum shading factor if desired. The value of the shading factor is relative to the window, which is shaded. For example, a shading factor of 0.3 corresponds to “light curtains” if the glazing is an “ordinary” two-layer glazing. For other glazings the shading factor must be corrected. The default factor is 0.3 where a factor 1 is “no shading”.

Button: "Database"
When the button "Database" is pressed the windows database appears.



In this dialogue the user defines the windows in the building. It is recommended to read the design guide that comes with the program (NB: In Danish only) before it is decided which windows to use.

In the main part of the dialogue the user should choose "The orientation of the house from north" as either 0º or 45º. Following the user has to define the windows in each direction of the house.

In the main list there are four reference windows that cannot be changed except the costs. The calculation of energy savings is based on a reference house that uses these values. It is however important that the costs of the reference window is estimated correctly.

Furthermore the user is presented to four very energy efficient windows placed in the four cardinal directions of the building, which is used as default windows in the user's building. The windows can be changed by marking the line of the window to be changed and then fill in the following information about the window:

- *Description;* user's own description (optional).
- *Window type;* the user can either select existing windows from the default database of windows in the "Window type" drop down menu or generate new windows in the "Window database".
- *Shading;* the user can choose default shadings in the "Shading" drop down menu or create a specific shading description pressing the "shadings" button to the right.

Press "Update" to store data.

"Orient." (orientation) is a value fixed by Dbuild as is "Inclination"; only 90º windows are possible in Dbuild version 1.0.

It is possible to add the users preferred windows to the "Window database" below the main list and use these as "Window type" in the main list. This is done as follows:

- *Description;* users own name for the window.
- *Glazing;* the user can either select an existing glazing from the default database in the "Glazing" drop down menu or generate new glazing units by pressing the button "Glazing and frames" to the right.
- *Frame;* the user can either select an existing frame from the default database in the "Frame" drop down menu or generate new frames by pressing the button "Glazing and frames" to the right.
- *U-value;* Dbuild automatically calculates the U-value of the window combined by the user.
- *Costs;* the user fills in the costs of the window in kr./m^2. NB: Remember to fill in the cost of your reference window as well.

Button: "Glazing and frames"
The user can generate new glazing units and frames by pressing the button "Glazing and frames" to the right of the "Window database". To generate a new glazing unit the user has to apply the following parameters:

- *Description;* user's own name for the glazing unit
- *U-value;* the center U-value of the window [W/m^2K]
- *Solar transmittance;* the g-value of the glazing unit [-]
- *Line loss;* the Ψ-value of the spacer in the glazing [W/mK]

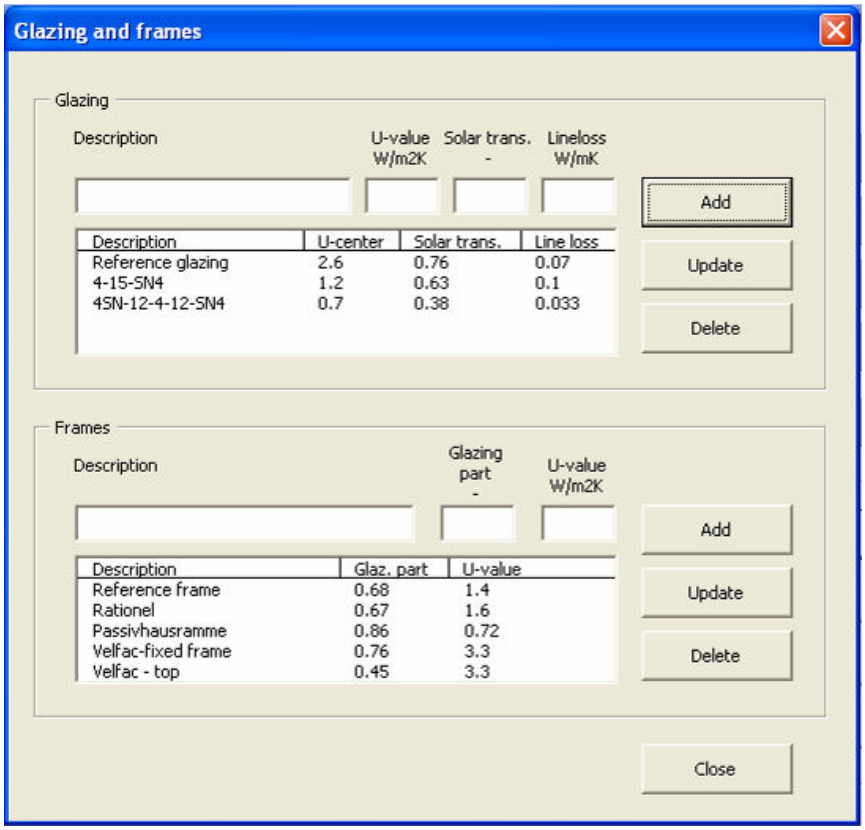
NB: remember to press "Add" to finally add the glazing unit. If you change some information about the glazing unit remember to press "Update".

To generate a new frame the user has to apply the following parameters:

- *Description;* user's own name for the glazing unit

- *Glazing part;* factor (0-1) that indicates how much frame there is in the combines window. A high factor indicates a slim frame and a lower factor indicates e.g. a 'Dannebrog Window' with a lot of frame.
- *U-value;* the center U-value of the window [W/m^{2}K]

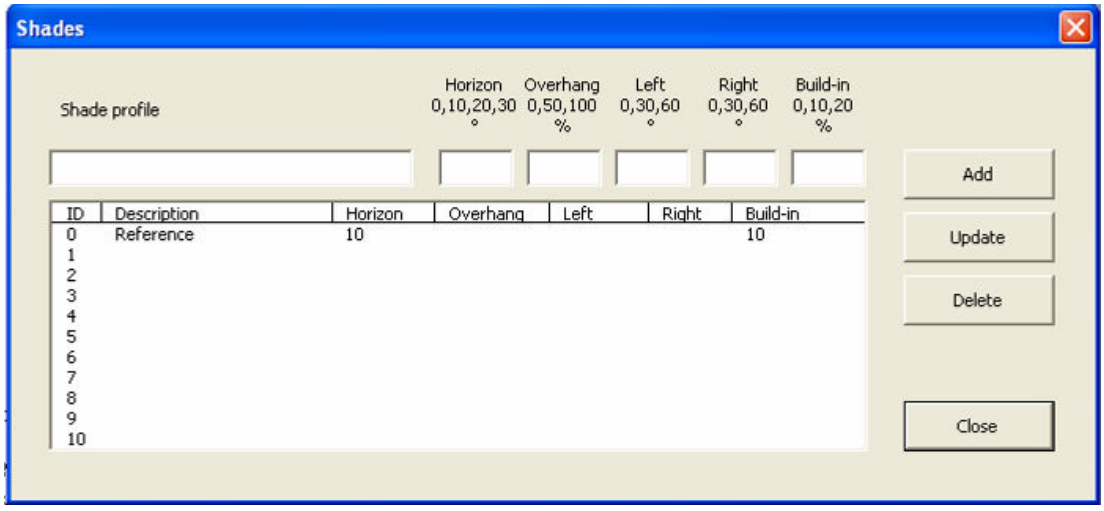
NB: remember to press "Add" to finally add the frame profile. If you change some information about the frame remember to press "Update".



Button: "Shades"
The user can create a specific shade description pressing the "shades" button to the right of the main list and fill in the following information about the shading:

- *Shading profile;* users own name for the shading profile.
- *Horizon;* depending on the surroundings of the building.
- *Overhang;* depending on size of the overhang.
- *Left shading;* depending on size of the shading.
- *Right shading;* depending on size of the shading.
- *Build-in;* depending on how deep the build-in is.

NB: remember to press "Add" to finally add the profile to the database. If you change some information about the glazing unit remember to press "Update".



Button: "Optimize"
By pressing the button "Optimize" the user starts an optimization of the areas and the amount of shading of the selected windows starting from the "Min. legal start values" or the "User start values".
The graphs to the right in the "Window" tab are the results of the optimization. The "Opt." (optimum) columns are the optimal amount of windows based on "Min. legal start values" (areas locked in the N, E and W direction) and the "user" columns are the optimal amount of windows based on the "User start values" (no areas locked). When optimizing further the window areas displayed as "user" are used.

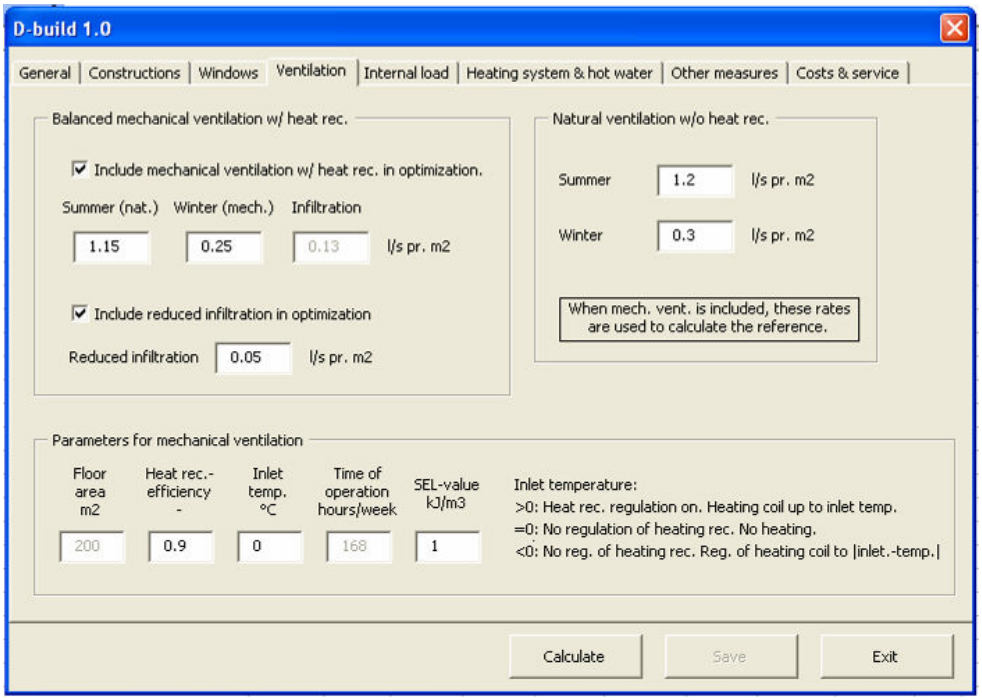
Net energy kWh/m^2
This text box shows the net energy use of the building for the "optimum" solution and the "user" solution.

No. of hours > 26ºC
This text box shows the number of hours > 26ºC in the building for the "optimum" solution and the "user" solution.

Check box: "Include windows in optimization"
If this check box is unchecked the optimization of windows is bypassed. The window types are then the reference windows (U = 2.3 W/m^2K) and the areas and orientations of the windows are as "Min. legal start values".

1.6 Ventilation

Due to The Danish Building Code (BR-S 98, supplement 9) the air change rate in a dwelling must be at least 0.5 h^{-1} corresponding to 0.3 l/s per m^2. This can be obtained in Dbuild by natural or mechanical/natural ventilation. Dbuild calculates the reference energy consumption of the building with natural ventilation.



Mechanical ventilation w/ heat rec.

In Dbuild mechanical ventilation and reduced infiltration is included as default. The mechanical ventilation is divided into a summer and a winter situation:

- *Summer (nat.);* in the summer time the mechanical ventilation is bypassed and the ventilation of the building is thereby natural ventilation. The summer ventilation rate should be raised due to the increased risk of overheating (more than 100 hours above 26ºC). The maximum value for raising the natural ventilation by opening windows and doors is 1.2 l/s per m^2 (Be05, 2005) – including infiltration. Default in Dbuild.
- *Winter (mech.);* in the winter time the mechanical ventilation is used. The ventilation rate is 0.3 l/s per m^2 including infiltration (default in Dbuild). The parameters of the ventilation unit are set in "Parameters for mechanical ventilation".

Parameters for mechanical ventilation

The user may fill in the following parameters of the ventilation system:

- *Floor area [m^2];* the floor area filled in by the user in the tab "General".
- *Heat rec. efficiency [-];* the efficiency of the heat recovery unit (from 0 to 1). See "Designguide" for further information.
- *Inlet temp. [ºC];* the inlet temperature is the temperature of the air coming into the building. In Dbuild the default value is 0 meaning that the inlet air has the temperature that the outdoor air obtains due to the heat recovery unit. By setting "Inlet temp." to a positive value the ventilation unit will regulate

the heat recovery and, if needed, heat the inlet air to 20ºC by using electrical power in a heating coil.
If the user fills in a negative value the heat recovery unit will not be regulated and the inlet temperature will be the numeric value of the filled in temperature (using heating coil if necessary).

- *Time of operation [hours/week];* value from the tab "General". 168 hours as default in Dbuild.
- *SEL-value [kJ/m^3];* SEL is the "specific electrical power consumption for air transport". This value must not exceed 1.2 kJ/m^3.

Natural ventilation w/o heat rec.
The natural ventilation is defined as follows:

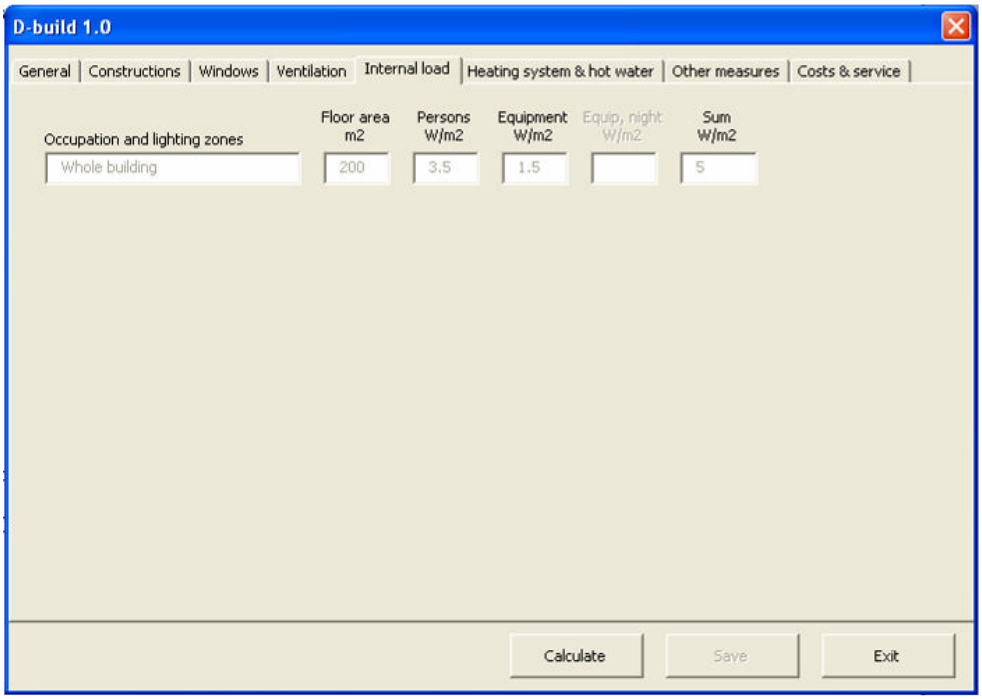
- *Summer;* the ventilation rate in the summer [l/s per m^2]
- *Winter;* the ventilation rate in the winter [l/s per m^2]

The natural ventilation is thereby divided into a summer and winter situation:

- *In the winter situation* the ventilation rate is 0.3 l/s per m^2 as demanded (default in Dbuild) – including 0.13 l/s per m^2 infiltration.
- *In the summer situation* the ventilation should be raised due to the increased risk of overheating (more than 100 hours above 26ºC). The maximum value for raising the natural ventilation by opening windows and doors is 1.2 l/s per m^2 (Be05, 2005) – including 0.13 l/s per m^2 infiltration. Default in Dbuild.

1.7 Internal load

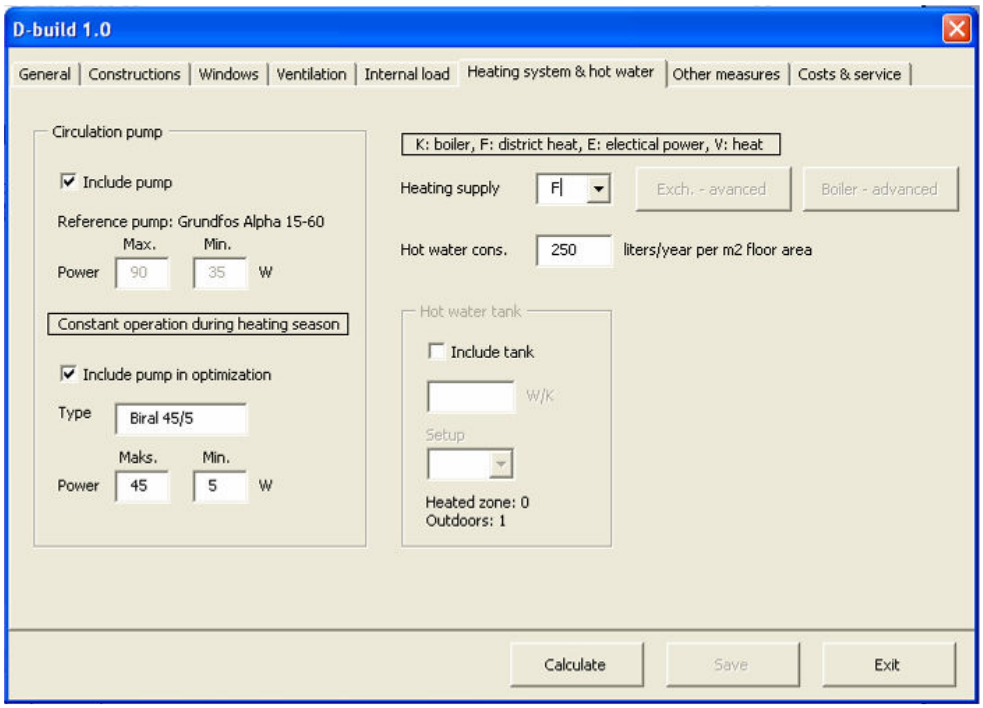
The internal load in dwellings cannot be optimized due to (Be05, 2005). This tab is implemented due to future updates of Dbuild, which may include e.g. design of offices where the internal load is an important part of the energy consumption.



This tab contains the following parameters:

- *Occupation and lighting zone;* user's description of the zone.
- *Floor area [m^2];* the floor area filled in by the user in the tab "General"
- *Persons [W/m^2];* the effect coming from the persons occupying the building. Default and fixed value of 3.5 W/m^2 in Dbuild, which corresponds to the minimum value in (Be05, 2005).
- *Equipment [W/m^2];* the effect coming from electrical equipment. Default and fixed value in Dbuild of 1.5 W/m^2 which corresponds to the minimum value in (Be05, 2005).
- *Equipment, night [W/m^2];* Feature not available in Dbuild version 1.0.
- *Sum [W/m^2];* The sum of internal loads ("Persons" and "Equipment").

1.8 Heating system & hot water



Heating system
The user can select the type of heating system:

- "K" is boiler (gas or oil).
- "F" is district heat
- "E" is electricity
- "V" is a heat pump

The buttons "Boiler – advanced" and "Exch. – advanced" (exchanger in a district heat system) are inactive in Dbuild version 1.0.

Circulation pump
The user may need a circulation pump, which is added by marking the checkbox "Include pump". The reference pump is a Grundfos Alpha 15-60 with power consumption 90/35 W. The pump is in constant operation during the heating season.

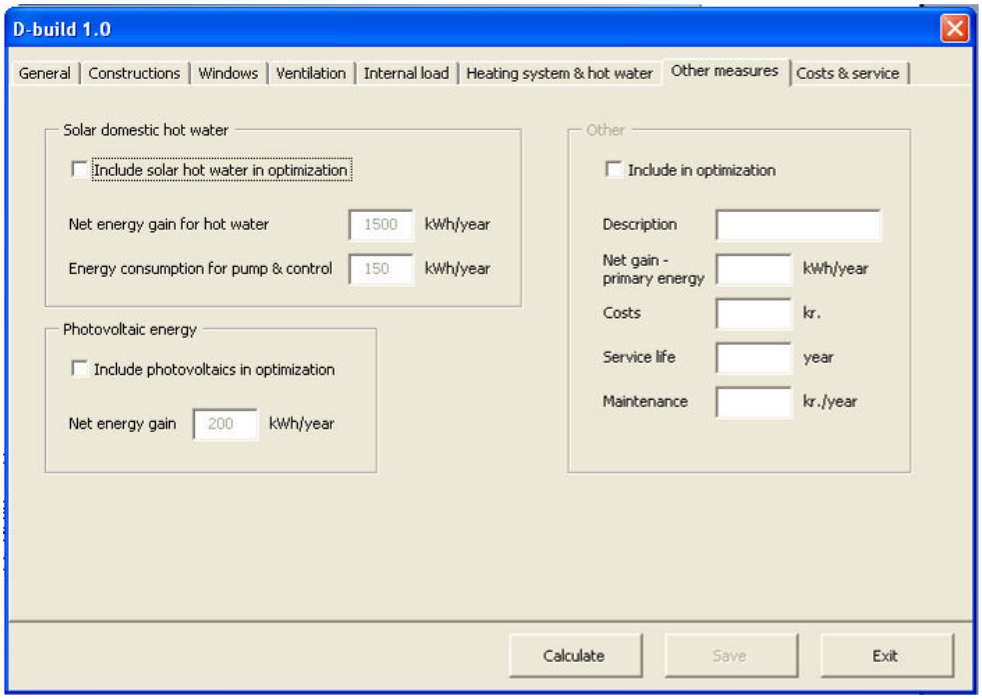
The user can choose to optimize the pump by marking the checkbox "Include pump in optimization". As an example of an optimized pump a Biral 45/5 is set as default.

Hot water consumption
The amount of hot water consumed in a dwelling is according to (Be05, 2005) 0,25 m^3 per m^2 floor area (250 liters). The default value in Dbuild is 250 liters.

Hot water tank
This feature is not activated in Dbuild version 1.0.

1.9 Other measures

Other measures are optional energy measures that can be added to the building if the user wants to.



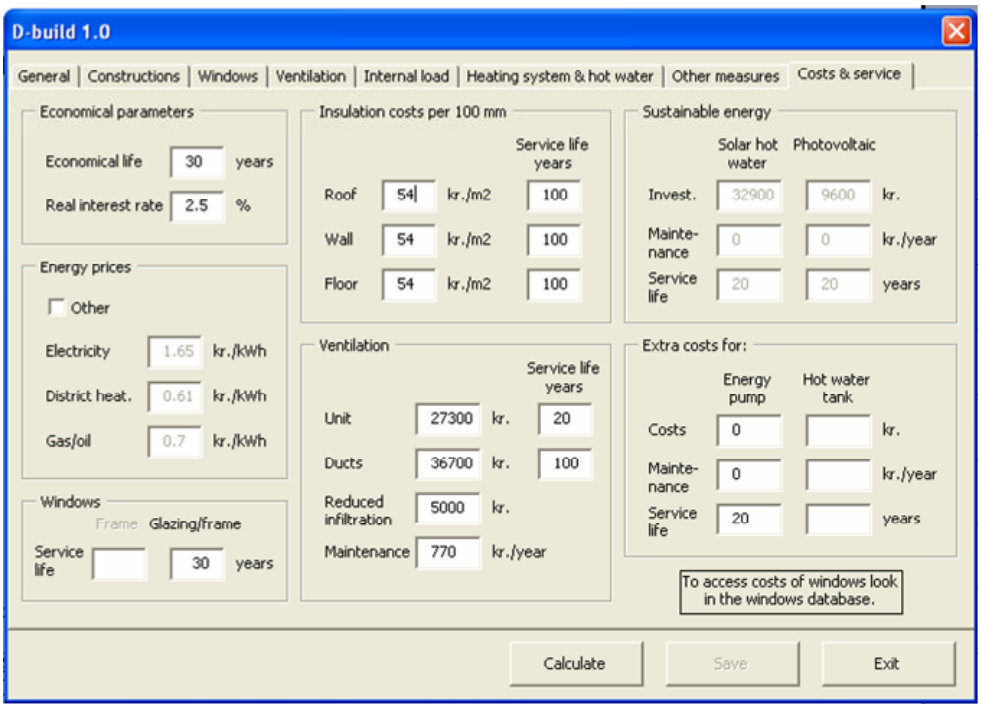
Solar domestic hot water
By marking the checkbox "Include solar hot water in optimization" the user must specify:

- The net energy gain for hot water in kWh/year. The default value is 1500 kWh/year corresponding to approx. 60% of the total hot water consumption in a dwelling.
- The energy consumption for pump and control in the solar hot water system in kWh/year

Photovoltaic energy
By marking the checkbox "Include photovoltaic in optimization" the user must specify the net energy gain by the photovoltaic compounds in kWh/year. The default value is 200 kWh/year corresponding to the net energy gain produced by 2 m^2 solar panels.

Other
This application is not active in Dbuild version 1.0.

1.10 Costs & service



Economical parameters
The economical parameters are used in the economic optimization, based on Cost of Saved Energy as described in the "Designguide" section **Fejl! Henvisningskilde ikke fundet.**:

- *Economical life;* the life span of the investment.
- *Real interest rate;* the minimum yield of the investment excl. inflation.

Energy prices
The user can change the default energy prices by marking the checkbox "Other". The default energy prices are:

- *Electricity;* 1.65 kr./kWh
- *District heat;* 0.61 kr./kWh
- *Gas/oil;* 0.70 kr./kWh

Windows
Here the user can change the service life of the window. The default value is 30 years. There is no distinction between the window frame and the glazing in Dbuild 1.0.

Cost of the windows are found in the window database (tab: “Window”).

Insulation costs per 100 mm
The user must fill in the prices of the insulation in the constructions “Roof”, “Wall” and “Floor”. The unit must be kr./m^2 per 100 mm insulation. The default values should be seen as suggestions.
Furthermore the user can change the service lifetime. Default value is 100 years.

Ventilation
If the user applies mechanical ventilation and reducing of infiltration the following information about the ventilation system must be applied (default values should be seen as suggestions):

- *Unit;* the price of the total ventilation unit and the service life.
- *Ducts;* the price of the duct system and its service life.
- *Reduced infiltration;* the price of reducing the infiltration.
- *Maintenance;* the maintenance costs of the ventilation system per year, e.g. filters and cleaning.

Sustainable energy
The following information about additional sustainable energy, solar hot water and photovoltaic technology, must be applied (default values should be seen as suggestions):

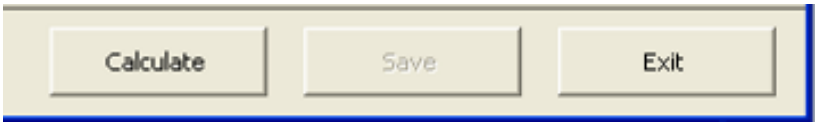
- *Invest.;* the size of the investment in kr.
- *Maintenance;* the maintenance costs of the investment.
- *Service life;* the service life of the investment in years.

Extra costs
The following information about additional extra costs must be applied:

- *Energy pump;* if an energy pump is chosen by the user, the price difference between the standard pump (in the area of 1,000 kr.) and the energy pump must be applied. Furthermore costs of maintenance per year and service life must be applied.
- *Hot water tank;* this application is not active in Dbuild version 1.0.

1.11 Calculate, save and exit

Calculate
After the user has pressed the button ”Calculate” the window optimization will run an update before the final CSE optimization initiates. Results will pop up automatically (see section 1.12).



Save

The button ”Save” is not functional in Dbuild version 1.0. The only way to save the project is when user press ”Exit”. However, Dbuild will always store the values filled in by the user even if program crashes.

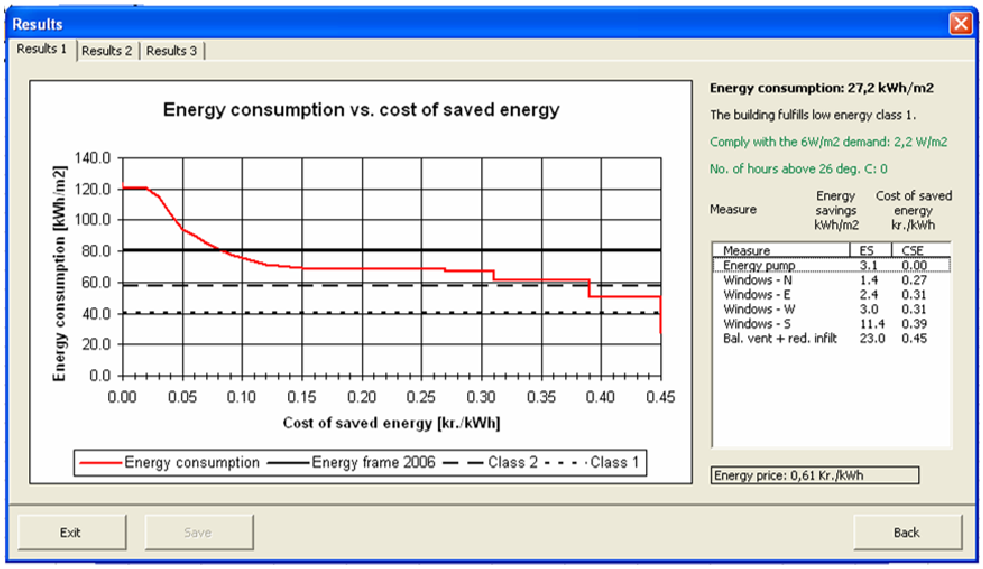
Exit

When the user presses ”Exit”, Excel will ask if the user wants to save the project. When the user has answered the Dbuild worksheet will be closed. Excel will still be open.

1.12 Output

After the calculation has finished, Dbuild generates an output window containing three tabs: Results 1, 2 and 3.

Result 1



This result tab contains the graph ”Energy consumption vs. Cost of Saved Energy”. This graph is generated specific to the energy solutions selected by the user. This means, that one constellation of energy solutions has a corresponding ”Energy consumption vs. Cost of Saved Energy” graph and another constellation of energy solutions has a different graph.
Therefore the user can not select all possible energy solutions, generate the ”Energy consumption vs. Cost of Saved Energy” graph, then ”read backwards” in the graph

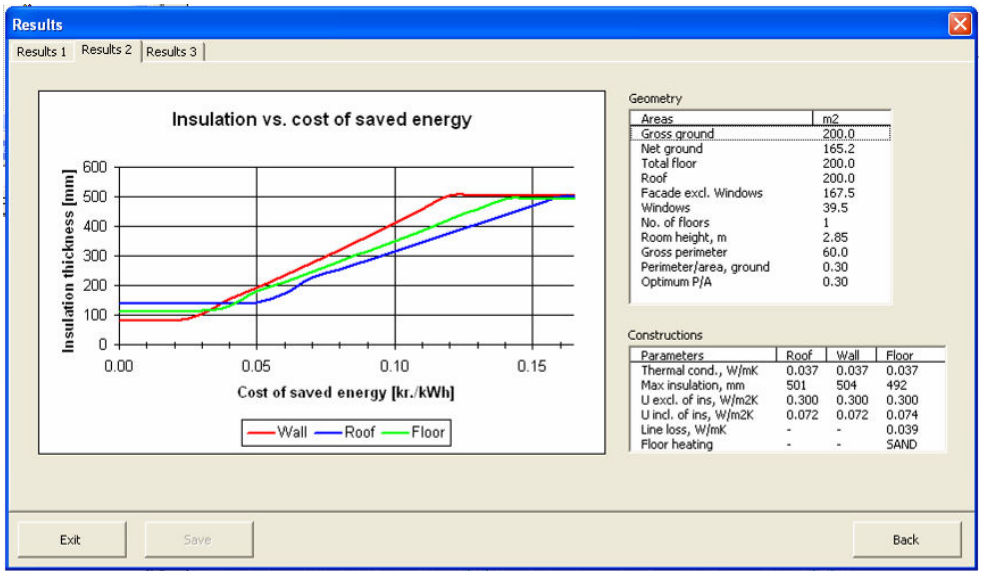
to the desired level of energy consumption and assume that this (reduced) constellation of energy solution will correspond to the energy consumption on the y-axis.

However, this ”read backward” principle is valid and useful because it gives a visual understanding of how to combine a constellation of energy solutions to acquire the desired level of energy consumption. The user has to select the solutions of this ”constellation idea” in Dbuild and run the program (press ”Calculate”) once again to generate a precise and correct ”Energy consumption vs. Cost of Saved Energy” graph of the desired constellation.

The energy saving and corresponding CSE of the selected energy solutions can be seen to the right of the ”Energy consumption vs. Cost of Saved Energy” graph. Furthermore the tab ”Result 1” also contains the following information:

- The ”Total energy consumption” of the desired constellation of energy solutions.
- Indication of which energy class the building is fulfilling.
- A calculation to assure that the demand of 6 W per m^2 building envelope (windows excluded) is fulfilled according to (Tillæg 9, 2005).
- The number of hours above 26ºC (indoor).
- Energy price of the selected energy source.

Result 2



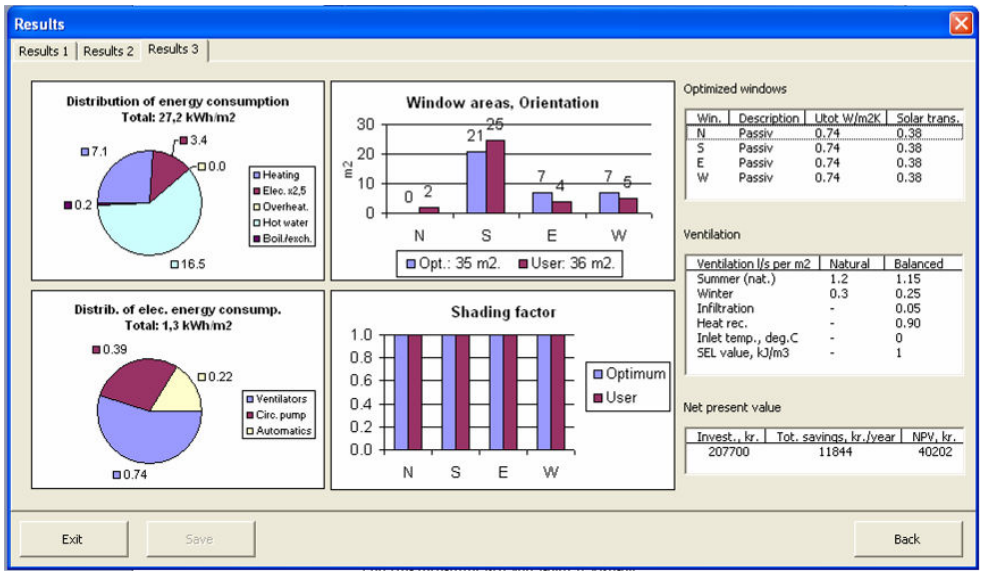
This result tab contains the graph ”Insulation vs. Cost of Saved Energy”. The graph is generated in respect of the ”Max. acceptable insulation thickness” in the tab ”Constructions”. In this graph the user can read the insulation thickness of the wall, roof and floor corresponding to any CSE.

Following information can be seen to the right of the ”Insulation vs. Cost of Saved Energy” graph:

- Geometry; a summary of the geometry parameters of the building.
- Constructions; parameters describing the constructions wall, roof and floor.

NB: The optimized insulation thickness in the wall, roof and floor is listed under ”Constructions”!

Result 3



This result tab contains four graphs:

- *Distribution of energy consumption;* the total energy consumption and distribution.
- *Distribution of electrical energy consumption;* the total electrical energy consumption and distribution.
- *Window areas, Orientation;* the area of windows and the corresponding orientation. The user columns are the design values.
- *Shading factor;* the shading factor of the corresponding window orientations. The user columns are the design values.

Furthermore the tab ”Result 2” contains:

- Data of optimized windows
- Data of ventilation, natural and balanced mechanical
- Calculation of net present value according to section **Fejl! Henvisningskilde ikke fundet.** in del A.

APPENDIKS **FEJL! INGEN TEKST MED DEN ANFØRTE TYPOGRAFI I DOKUMENTET. FEJL! INGEN TEKST MED DEN ANFØRTE TYPOGRAFI I DOKUMENTET.**